

SOME EUROPEAN PAVEMENTS—REPORT.

MR. E. H. THOMES, Mem. Am. Soc. C.E., assistant engineer, Bureau of Highways, Borough of Queens, New York City, has returned from a tour of inspection of roads and pavements in Europe, and has presented a report containing some good information on paving materials and paving methods in numerous localities. The following is a summary:—

Pavement Studies in Liverpool.—At Liverpool, City Engineer John A. Brodie is conducting measurements of pavement wear under actual traffic. Cast iron sockets are imbedded in independent concrete supports in the sidewalk, and sometimes an additional one in the centre of the street. In these sockets can be placed standards which carry a taut wire device or a stiff wooden straight edge with sliding T square and vernier scale for the accurate measurements of the road surface. Each apparatus is adjustable so that accurate measurements can always be taken under similar conditions.

The oldest example of pitch grouted macadam in Liverpool was laid on Princes Street in 1901 and has been in continuous use ever since without any repairs. It is still in very good condition, with a mosaic surface having a good contour excepting a few slight depressions; in places it has a slight surface flush of tar still showing life. The traffic here amounts to about 120,000 tons per yard width per year. An adjoining water-bound macadam in the same street has cost from 10 cents to 25 cents per square yard per annum for repairs. The following figures show the average depth of wear in inches per annum on Princes Street:—

For water-bound macadam 0.54 in. per year
 For tar treated water-bound macadam.. 0.35 in. per year
 For pitch macadam 0.15 in. per year

Mr. Brodie showed a very interesting object lesson of the relative wear of the pitchmac on Princes Street and the plain macadam adjoining. A section of each had been removed and the tar washed out and the mineral aggregate separated into sizes. The plain macadam stone was all rounded with a large percentage of fine stuff, showing the wear from the rubbing and grinding effects which extend to a considerable depth in ordinary macadam, especially in wet weather. The stone from the tar macadam showed only a slight wear and rounding on the surface stones, the rest had practically as sharp edges as when laid twelve years ago.

More satisfactory results with tar macadam seem to have been obtained in Liverpool and other places in Great Britain than in most other countries. The improved results here, as well as at a few places on the Continent, seem to be due to some extent to the good quality of tar used, which in some places appears to be better than that usually obtained in the United States. Moreover, Great Britain has a more moist and more uniform climate than New York, with less extremes of frost and heat with their deteriorating effects. Tar has been used for almost all bituminous macadam work abroad, but the American natural and artificial asphalt paving cements are being introduced into Europe and are meeting with favor. It is generally considered that natural asphalt is better than tar for paving under most conditions, but in many cases it is an open question whether the results justify the usual additional expense of the asphalt.

A good practice which is increasing in favor here and abroad is to use tar in the lower part and asphalt for the wearing surface. Tar is less affected than asphalt by

dampness, ordinarily in foundations, it is cheaper and more easily manipulated and for a longer period before hardening, but the asphalt is less affected by the extremes of temperature on the surface and it seems to withstand traffic better and lasts longer. Tar has been used longer and in a greater variety of methods of paving constructions in England than in any other country, but failures have occurred in all places.

Pitchmac pavement was developed by Mr. Brodie and the bituminous binder is sold by S. R. Clare & Co., Liverpool, under the trade name of "Pitchmac." The pavement contains about 13 per cent. of binder. A similar pavement was under construction upon an old cobble-stone pavement as a foundation. A 3-in. loose layer of new $2\frac{1}{2}$ -in. stone on top of the old foundation was well rolled and then covered from hand dippers with $1\frac{1}{4}$ gals. of tar mixture per square yard. This was then covered with a $2\frac{1}{2}$ -in. loose layer of $1\frac{1}{2}$ -in. stone well rolled and covered with about $1\frac{1}{2}$ gals. of tar mixture. This was rolled hot with a 10-ton roller and covered with a layer of clean, dry, warm stone chips and rolled to a finish. Gasoline torches were used to dry the stone as laid in the roadway just prior to the tarring. The tar mixture consists of equal parts of refined coal tar and fine sand containing about 3 per cent. of powdered chalk. The hot materials were brought onto the street in two separate wagons by a traction engine from the central plant. The tar tank was covered with asbestos and black canvas, and held about 1,000 gals. The tar and sand were mixed together by a special mixing machine from which the mixture was wheeled along the street and dipped out and spread on the prepared broken stone. Mr. Brodie thinks he gets cheaper and better results with the mixture than with tar alone. The sand reduces the expense and stiffens the binder and the chalk or limestone dust seems to toughen it. Good results have also been obtained with this mixture as a joint filler and as a maintenance coating on new and old stone and wood block pavements. This idea seems worthy of a trial here.

Owing to the great increase of traffic, the tendency abroad as well as here is to strengthen and increase a well drained stone or concrete foundation to a depth of from 6 to 12 ins. and maintain a wearing surface of stone or wood block, or bituminous material, suitable to the traffic and local conditions.

Stone Block Pavement.—Table I. shows the percentages of pavement in ten German cities which were visited. The largest percentage here and elsewhere abroad is stone block pavement. The blocks vary in size from the small 3-in. blocks in Liverpool to the large blocks used in southern Europe. I was much interested in the old Roman type of road with large irregular stone blocks, laid close together, and the later type still in use in Italy of large rectangle stone slabs from 1 to 2 ft. wide, from 1 to 3 ft. long and about 6 ins. or more thick, mostly with a sand bed and joint, some with mortar.

In France alone there are about 120 types of stone block pavements differing either in dimensions, permissible variations or taper. An effort is being made abroad, as has been done in this country, to standardize the sizes of stone paving blocks. The tendency abroad as here is to reduce the depth of block to about 5 or 6 ins. The length varies from 5 to 14 ins. and the width from 3 to 8 ins. Sand, gravel, cinders, broken stone, concrete, etc., are used for foundations. Sand, cement mortar, cinders, fine gravel, stone chips, and tarred chips are used for bed and the same materials are also used in the joints, also tar and other bituminous materials, but sand and tar are